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MARKED-UP VERSION OF SUBSTITUTE SPECIFICATION

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~~SPECIFICATION~~

SKATEBOARD

BACKGROUND OF THE INVENTON

1. Field of the Invention

~~TECHNICAL FIELD~~

【0001】

The present invention relates to a skateboard, and more specifically, the present invention relates to a powered skateboard which includes a drive wheel supplied with rotary power by a drive motor.

2. Description of the Related Art~~BACKGROUND ART~~

【0002】

Conventionally, powered skateboards that are driven by~~drivable with~~ a drive motor are known, an example of which is disclosed in JP-A 2000-140190, which is hereinafter referred to as Patent Document 1.

【0003】

According to the powered skateboard disclosed in Patent Document 1, the drive motor and the drive wheel supplied with rotary power by the drive motor are provided on a bottom side of the board. Further, a motor controller~~control means~~, which includes a controller for controlling the motor, a battery as a power source and so on, is attached to a bottom surface of the board.

~~【Patent Document 1】 JP-A 2000-140190~~

~~DISCLOSURE OF THE INVENTION~~

~~PROBLEMS TO BE SOLVED BY THE INVENTION~~

【0004】

According to this technique, however, the controller and the battery are attached entirely and integrally with the board. Therefore, when the board is used and as the board is deformed by~~with~~ the rider's weight, the deformation load, for example, acts directly on the controller or the battery, potentially causing an adverse influence on the controller or the battery.

【0005】

In order to reduce the deformation of the board, the board may be made of a material which has a high strength/rigidity rather than a flexible structural material, or the board may be provided with a reinforcing member for enhanced strength/rigidity. However, superior strength/rigidity will lead to unnatural riding and operability.

SUMMARY OF THE INVENTION

【0006】

In order ~~It is therefore a primary object of the present invention~~ to overcome the problems described above, preferred embodiments of the present invention provide a skateboard that provides a~~capable of offering~~ natural ride and good operability without adversely influencing a drive power

controller~~controlling means~~ such as a controller and a battery.

~~MEANS FOR SOLVING THE PROBLEMS~~

【0007】

According to a preferred embodiment~~an aspect~~ of the present invention, ~~there is provided~~ a skateboard ~~which~~ includes~~:~~ a board,~~;~~ wheels provided on a bottom side of the board~~,~~ at ~~a~~ front and ~~a~~ rear regions thereof, a ~~;~~ motor controller arranged to supply~~control means for supplying~~ at least one of the wheels with rotary power,~~;~~ a case provided on a bottom side of the board and housing the motor controller,~~control means;~~ and a fixing element arranged to fix~~means for fixing~~ a center region of the case to the board, leaving ~~a~~ front and ~~a~~ rear end regions of the case free.

【0008】

According to ~~the present invention,~~ a preferred embodiment of the present invention, an approximately central~~generally center~~ region of the case is fixed to the board by the fixing element~~means~~, and the front and the rear ends of the case are free ends. Therefore, for example, when the rider applies a~~his~~ load onto the board, causing the approximately central~~making the generally center~~ region of the board to be displaced (flexed~~displace (flex~~) in vertical directions on the front and the rear wheels serving as fulcrum points, the case does not deform so there is no adverse influence on the motor controller, which may include~~control means such as~~ a controller and a battery. Further, since the board is not

subject to a resisting force from the case against the deflection of the board, good operability by the rider's feet is obtained, and a natural comfortable ride can be assured due to suspension.

【0009】

According to another preferred embodiment~~aspect~~ of the present invention, ~~there is provided~~ a skateboard ~~which~~ includes~~:~~ a board,~~;~~ wheels provided on a bottom side of the board~~,~~ at ~~a~~ front and ~~a~~ rear regions thereof, a ~~;~~ motor controller arranged to supply~~control means for supplying~~ at least one of the wheels with rotary power,~~;~~ a case provided on a bottom side of the board and housing the motor controller,~~control means;~~ and a support member arranged to support~~supporting means for supporting~~ the case on the bottom side of the board, and move~~capable of moving~~ longitudinally relative to~~of~~ the board at least when a load is applied on the board.

【0010】

According to this preferred embodiment of the present invention, even if the rider applies a~~his~~ load onto the board and causes~~makes~~ the generally central~~center~~ region of the board to be displaced (flexed~~displace (flex~~) in vertical directions, the support member~~supporting means~~ of the case moves in fore-and-aft directions (longitudinally of the board) in accordance with the amount of displacement, reducing the deformation load, vibration, force, etc. that is applied to the case. Use of the skateboard under such a condition does

not deform the case, ~~and~~ so there is no adverse influence on the motor ~~control means such as the~~ controller, which may include, for example, a controller, a ~~the~~ battery and other elements.~~so on.~~ Further, since the board is not subject to a resisting force from the case against the deflection of the board, good operability by the rider's feet is obtained, and a natural comfortable ride can be assured due to suspension.

【0011】

Preferably, the skateboard further includes a weight transfer detection sensor for detecting weight transfer of a rider riding on the board. The motor controller is preferably arranged to supply~~control means supplies~~ the wheel with the rotary force in accordance with a detection signal from the weight transfer detection sensor. In this case, good driving control of~~can be made on~~ the wheel in accordance with the weight transfer of~~by~~ the rider can be achieved.

【0012】

Further, preferably, the board is made of ~~provided by~~ a flexible structural material. In this case, the board flexes in vertical directions, making it possible to further improve operability by the rider's feet, further improve riding comfort due to suspension, and contribute to reduced weight.

【0013】

The present invention is advantageous when the motor controller~~control means~~ includes a controller or a battery which is susceptible to bending.

【0014】

Further, preferred embodiments of the present invention

are ~~is~~ advantageous when the controller includes a plurality of batteries which are electrically connected with each other. Since each battery is heavy, the electrical connection between the batteries is likely to be cut by applied ~~a~~ stress. However, according to preferred embodiments of the present invention, the case does not deform, and thus~~so~~ does not exert stress on the batteries, preventing such a problem.

【0015】

The term "skateboard" used in the description of preferred embodiments of the present invention means a mobile body which includes a plurality of wheels and a board disposed thereon, for a rider to ride on an upper surface of the board to transport.

~~BRIEF DESCRIPTION OF THE DRAWINGS~~

【0016】

Other features, elements, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments thereof with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

~~【Fig. 1】~~

~~A perspective view showing an embodiment of the present invention.~~

~~【Fig. 2】~~

~~A side view showing a skateboard without an intermediate~~

~~portion.~~

~~【Fig. 3】~~

~~A schematic diagram of a section, showing how a front wheel which serves as a free wheel is attached.~~

~~【Fig. 4】~~

~~A conceptual diagram of a section, showing a construction of a rear wheel which serves as a drive wheel, and how it is attached.~~

~~【Fig. 5】~~

~~A conceptual diagram of a section, showing inside of a case and how the case is attached.~~

~~【Fig. 6】~~

~~A conceptual diagram as a plan view, showing an inside of the case.~~

~~【Fig. 7】~~

~~A controller block diagram of the skateboard.~~

~~【Fig. 8】~~

~~A conceptual diagram showing how the case is supported when no load is applied in the embodiment in Fig. 1.~~

~~【Fig. 9】~~

~~A conceptual diagram showing how the case is supported when a load is applied in the embodiment in Fig. 1.~~

~~【Fig. 10】~~

~~Shows a primary portion of another embodiment of the present invention: Fig. 10(a) is a conceptual diagram as a side view, and Fig. 10(b) is a conceptual diagram as a bottom view.~~

~~【Fig. 11】~~

~~A perspective view of the case used in the embodiment in Fig. 10.~~

~~【Fig. 12】~~

~~A conceptual diagram showing how the case is supported when no load is applied in the embodiment in Fig. 10.~~

~~【Fig. 13】~~

~~A conceptual diagram showing how the case is supported when a load is applied in the embodiment in Fig. 10.~~

~~【Fig. 14】~~

~~Shows another embodiment of the present invention: Fig. 14(a) is a conceptual diagram as a plan view, Fig. 14(b) is a conceptual diagram showing how the case is supported when no load is applied, and Fig. 14(c) is a conceptual diagram as a bottom view.~~

~~【Fig. 15】~~

~~Fig. 15(a) is a conceptual diagram showing how the case is supported when a load is applied in the embodiment in Fig. 14, Fig. 15(b) is a conceptual diagram as a bottom view.~~

~~【Fig. 16】~~

~~A conceptual diagram of a section, showing a case housing two controllers.~~

~~LEGEND~~

【0017】

Fig. 1 is a perspective view showing a preferred embodiment of the present invention.

~~1 Skateboard~~

~~3 Board~~

~~5, 7 ―――――― Wheels~~

~~9, 9a ―――――― Controllers~~

~~11 ―――――― Battery~~

~~12 ―――――― Motor control means~~

~~13 ―――――― Case~~

~~15 ―――――― Drive motor~~

~~25, 69 ―――――― Long holes~~

~~51 ―――――― Fixing bolt~~

~~53, 55 ―――――― Weight transfer detection sensors~~

~~61 ―――――― Rod member~~

~~63 ―――――― Guide rail~~

~~65 ―――――― Bolt~~

~~67 ―――――― Nut~~

~~BEST MODE FOR CARRYING OUT THE INVENTION~~

【0018】

~~Hereinafter, embodiments of the present invention will be described with reference to the drawings.~~

~~Referring to~~ Fig. <u>2 is a side view showing a skateboard without an intermediate portion.</u>~~1, a skateboard 1 as an embodiment of the present invention includes a platy board (deck) 3. In a front and a rear regions on a bottom side of the board 3, wheels 5 and 7 are provided respectively. At a generally center region of a bottom surface of the board 3, a case is supported as shown in Fig. 5 and Fig. 6, which houses a motor control means 12 which includes a drive motor controller (control circuit board) 9 and a battery 11 which serves as a power source of the controller 9. The controller~~

~~9 and the battery 11 are fixed on a bottom surface of the case 13. The battery 11 includes, for example, a plurality (sixteen in the present embodiment) of cells 11a which are electrically connected in series by welding. The cells 11a are provided by Ni-Cd battery cells for example. Note that in Fig. 5 and Fig. 6, a reference code "11b" indicates a weldment at which mutually adjacent cells 11a are connected with each other~~

【0019】

<u>Fig. 3 is a schematic diagram of a section, showing how a front wheel which serves as a free wheel is attached.</u>

~~The board 3 is made of flexible structural material such as plywood, so that it is generally horizontal as shown in Fig. 8 under no load, but flexes in vertical directions under a load as shown in Fig. 9, bringing a center portion into a downwardly recessed curve on a front and a rear wheels 5, 7 serving as fulcrums. Since the flexible structural material flexes in vertical directions, it provides improved operability by feet, providing suspension which improves riding comfort, as well as contributes to reduced weight. The flexible structural material should preferably have a spring coefficient between 15 kg/cm and 30 kg/cm. In the present embodiment, a flexible structural material having a 20 kg/cm spring coefficient (sagging 1 cm under a 20 kg load) is used. The flexible structural material is also called flexibly bendable material.~~

【0020】

<u>Fig. 4 is a conceptual diagram of a section, showing a</u>

construction of a rear wheel which serves as a drive wheel, and how it is attached.

~~Each of the wheels 5, 7 is a single wheel. The wheel 5 in the front serves as a free wheel whereas the wheel 7 at the rear serves as a drive wheel which incorporates a drive motor 15.~~

【0021】

~~Referring to~~ Fig. 5 is a conceptual diagram of a section, showing the inside of a case and how the case is attached. ~~2 and Fig. 3, the free wheel or the wheel 5 is rotatably supported by a supporting arm 17. The supporting arm 17 is formed in a downward facing U, and includes an upper arm portion 17a, and a right and a left arm portions 17b, 17b. The upper arm portion 17a is supported pivotably freely in 360 degrees by a fixed frame 21 via an arm shaft 19. As shown in Fig. 1, the fixed frame 21 is integrally fixed to and supported on a bottom surface of the board 3 with six fastening bolts 23.~~

【0022】

Fig. 6 is a conceptual diagram as a plan view, showing an inside of the case.

~~Each of the right and the left arm portions 17b, 17b has a long hole 25 which extends in forward and rearward directions. The long hole 25 is provided with a wheel attaching shaft 27 which rotatably supports the wheel 5. Therefore, attaching location of the front wheel or the wheel 5 is adjustable within the long hole 25 by moving the wheel in the forward or rearward direction for a desired turning characteristic of the~~

~~skateboard 1.~~

【0023】

~~Referring to~~ Fig. 7 is a controller block diagram of the skateboard ~~2 and Fig. 4, a hollow fixed sleeve 29 is provided inside the drive wheel or the wheel 7, and the drive motor 15 is fixed within the fixed sleeve 29. A bearing 31 is provided on each side of the fixed sleeve 29. The bearings 31 rotatably support the wheel 7. The fixed sleeve 29 has two side portions 29a, each integrally fixed to and supported by a supporting arm 35 via a wheel attaching shaft 33~~.

【0024】

Fig. 8 is a conceptual diagram showing how the case is supported when no load is applied in the preferred embodiment in Fig. ~~The supporting arm 35 is formed in a downward facing U, and includes an upper arm portion 35a, and a right and a left arm portions 35b, 35b which provides fixed support to the side portions 29a of the fixed sleeve 29. The upper arm portion 35a is pivotable freely in 360 degrees around an arm shaft 37, and is supported by a fixed frame 39. The fixed frame 39 is integrally fixed to and supported on a bottom surface of the board 3 with six fastening bolts 4~~1.

【0025】

Fig. 9 is a conceptual diagram showing how the case is supported when a load is applied in the preferred embodiment in Fig. 1.

~~The drive motor 15 is controlled based on signals from the controller 9 powered by a battery 11. A drive gear 45 is inserted around the motor shaft 43. The drive gear 45~~

~~engages with a middle gear 47, and the middle gear 47 engages with an internal gear 49 which is provided inside the wheel 7, whereby a rotating force after speed reduction in accordance with gear ratios between the gears is transmitted to the wheel 7.~~

【0026】

Figs. 10(a) and 10(b) illustrate a primary portion of another preferred embodiment of the present invention, wherein Fig. 10(a) is a conceptual diagram as a side view, and Fig. 10(b) is a conceptual diagram as a bottom view.

~~As shown in Fig. 1, Fig. 5, the controller 9 and the battery 11 are housed in a case 13, a generally center region of which is fixed to and supported on the bottom surface of the board 3, with fixing means or fixing bolts 51. Thus, a front and a rear ends of the case 13 are free ends. The fixing bolts 51 should preferably be round head bolts as shown in Fig. 5. Alternatively, flat head bolts may be used so the heads will not protrude from the board 3.~~

【0027】

Fig. 11 is a perspective view of the case used in the preferred embodiment shown in Figs. 10(a) and 10(b).

~~Fixed supporting by means of the fixing bolt 51 may be a single-point support at the central region or a multi-point support. If the multi-point support is used, preferably as shown in Fig. 1, the fixing bolts 51 should line up on Line X which crosses the board 3, i.e. perpendicularly to the the longitudinal directions of the board 3.~~

【0028】

Fig. 12 is a conceptual diagram showing how the case is supported when no load is applied in the preferred embodiment shown in Figs. 10(a) and 10(b).

~~The controller 9 is supplied with detection signals from a weight transfer detection sensor 53 placed closer to the fore foot and a weight transfer detection sensor 55 placed closer to the rear foot as shown in Fig. 2. The weight transfer detection sensor 53 for the fore foot is attached to the fixed frame 21 which supports the wheel 5 whereas the weight transfer detection sensor 55 for the rear foot is attached to the fixed frame 39 which supports the wheel 7.~~

【0029】

~~Referring to~~ Fig. 13 is a conceptual diagram showing how the case is supported when a load is applied in the preferred embodiment shown in Fig. 10(a) and 10(b). ~~7, the controller 7 includes a CPU 57 and a driver 59. The CPU 57 is supplied with: a voltage at a voltage dividing point P of a voltage divider circuit which is made of series connection of the fore foot and rear foot weight transfer detection sensors 53, 55; a voltage from a speed sensor S provided by an encoder indicating the speed of wheel 7; and a drive current of the drive motor 15 supplied from a feedback circuit F. The CPU 57 and the driver 59 is mounted on a substrate which is made of such a material as glass-epoxy resin.~~

【0030】

Figs. 14(a)-14(c) illustrate another preferred embodiment of the present invention in which Fig. 14(a) is a conceptual diagram as a plan view, Fig. 14(b) is a conceptual diagram

showing how the case is supported when no load is applied, and Fig. 14(c) is a conceptual diagram as a bottom view.

~~The weight transfer detection sensors 53, 55 for the forward and the rearward feet have the same resistance characteristic. When a load is applied from the fore foot, the resistance value of the fore foot weight transfer detection sensor 53 decreases in inverse proportion to the load. When a load is applied from the rear foot, the resistance value of the rear foot weight transfer detection sensor 55 decreases in inverse proportion to the load. Therefore, when there is no load or the same amount of load exerted on both of the detection sensors 53 and 55, the voltage at the voltage dividing point P of the voltage divider circuit becomes a half of voltage divider circuit source voltage V. On the other hand, when the rider transfers his weight on the board 3, to increase the load on the fore foot weight transfer detection sensor 53 over the load on the rear foot weight transfer detection sensor 55, the voltage becomes higher than V · 1/2, by the amount proportional to the difference between the loads detected by the two detection sensors. Likewise, when the rider makes a weight transfer to decrease the load on the fore foot weight transfer detection sensor 53 to become smaller than the load on the rear foot weight transfer detection sensor 55, the voltage becomes lower than V·1/2, by the amount proportional~~

~~to the difference between the loads detected by the two detection sensors.~~

【0031】

Fig. 15(a) is a conceptual diagram showing how the case is supported when a load is applied in the preferred embodiment of Figs. 14(a)-14(c), and Fig. 15(b) is a conceptual diagram as a bottom view.

~~The CPU 57 generates drive command signal (PWM: Pulse Width Modulation signal) whose pulse width represents the voltage at the voltage dividing point P of the voltage divider circuit, and sends the signal to the driver 59 at the next stage of the circuit. Based on the drive command signal from the CPU 57, the driver 59 outputs a drive current to the drive motor 15.~~

【0032】

Fig. 16 is a conceptual diagram of a section, showing a case housing two controllers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

~~According to the skateboard 1 as described above, when the rider on the board 3 transfers his weight to his fore foot, the CPU 57 sends to the driver 59 a drive command signal which has a pulse width representing the difference between the loads on the forward foot side and the rearward foot side. The drive motor 15 is supplied with a drive current corresponding to the pulse width, and begins to accelerate or to travel forward. On the other hand, when the rider transfers his weight to his rear foot, the CPU 57 sends~~

~~to the driver 59 a drive command signal which has a pulse width representing the difference between the loads on the forward foot side and the rearward foot side (a drive command signal which has a reverse amplitude of the amplitude when the weight transfer is to the fore foot). The drive motor 15 is fed with a drive current corresponding to the pulse width, and begins to decelerate or to travel rearward.~~

【0033】

Hereinafter, preferred embodiments of the present invention will be described with reference to the drawings.

Referring to Fig. 1, a skateboard 1 according to a preferred embodiment of the present invention includes a board (deck) 3. In front and rear regions on a bottom side of the board 3, wheels 5 and 7 are provided, respectively. At a generally central region of a bottom surface of the board 3, a case is supported as shown in Fig. 5 and Fig. 6, which houses a motor controller 12 which preferably includes a drive motor controller (control circuit board) 9 and a battery 11 which defines a power source of the controller 9. The controller 9 and the battery 11 are preferably fixed on a bottom surface of the case 13. The battery 11 includes, for example, a plurality (for example, sixteen in the present preferred embodiment) of cells 11a which are electrically connected in series, for example, by welding. The cells 11a are defined by Ni-Cd battery cells, for example. Note that in Fig. 5 and Fig. 6, reference numeral "11b" indicates a connection portion, such as a weld joint, for example, at which mutually adjacent cells 11a are connected with each other.

~~According to the skateboard 1 as described, the case 13 is fixed at its generally center region with the fixing bolts 51, making free the front and rear ends of the case 13. Therefore, even if the load from rider is applied to the board 3 and a generally center region of the board 3 deflects in a downward direction on the fulcrums provided by the front and the rear wheels 5, 7 (e.g. even if a state change occurs from a state in Fig. 8 to a state in Fig. 9), the case 13 is not deformed, and there is no adverse influence on the motor control means 12 such as the controller 9 and the battery 11 which are component susceptible to deflection. Therefore, it becomes possible for example, to prevent a weldment 11b from coming off the battery 11a, resulting in electrically open circuit between the batteries 11a. Further, since the board 3 is not subject to a resisting force from the case 13 against the deflection of the board 3, good operability by the feet is obtained, and natural comfortable ride can be assured due to suspension.~~

【0034】

The board 3 is preferably made of flexible structural material such as plywood, so that it is generally horizontal as shown in Fig. 8 under no load, but flexes in vertical directions under a load as shown in Fig. 9, bringing a center portion into a downwardly recessed curve on a front and a rear wheels 5, 7 serving as fulcrums. Since the flexible structural material flexes in vertical directions, it provides improved operability by a rider's feet, providing suspension which improves riding comfort, as well as contributing to

reduced weight. The flexible structural material should preferably have a spring coefficient between about 15 kg/cm and about 30 kg/cm. In the present preferred embodiment, a flexible structural material having an approximately 20 kg/cm spring coefficient (sagging about 1 cm under an approximately 20 kg load) is preferably used. The flexible structural material is also called flexibly bendable material.

~~Further, the motor control means 12 supplies the wheel 7 with a rotary power in accordance with detection signals from the weight transfer detection sensors 53, 55. This makes possible to provide good control on the drive of the wheel 7 in accordance with the weight transfer of the rider.~~

【0035】

Each of the wheels 5, 7 is preferably a single wheel. The wheel 5 in the front preferably serves as a free wheel whereas the wheel 7 at the rear preferably serves as a drive wheel which incorporates a drive motor 15.

~~Next, Figs. 10(a) and (b) show another embodiment in which a case 13 is supported on the bottom surface side of the board 3.~~

~~In the present embodiment, as clearly understood from Fig. 11, the case 13 has four rod members 61 on its two longitudinal side surfaces, each of the rod members extending perpendicularly to the side surface at a place closer to a longitudinal end of the side surface. On the other hand, the board 3 has a bottom surface provided with four guide rails 63, each of which has a generally L shaped section and serves as supporting means for the rod members 61. As clearly~~

~~understood from Fig. 10(b), each guide rail 63 is provided at a place corresponding to one of the rod members 61, and supports the rod member 61. Under this state, the center region of the case 13 is free.~~

【0036】

Referring to Fig. 2 and Fig. 3, the free wheel or the wheel 5 is rotatably supported by a supporting arm 17. The supporting arm 17 is preferably formed in a downward facing U, and includes an upper arm portion 17a, and right and left arm portions 17b. The upper arm portion 17a is supported pivotably freely in a range of 360 degrees by a fixed frame 21 via an arm shaft 19. As shown in Fig. 1, the fixed frame 21 is integrally fixed to and supported on a bottom surface of the board 3 by a plurality of fastening bolts 23, for example.

~~As shown in Fig. 12, the board 3 is upwardly curved under no load. The rod members 61 are un-slidably supported by the guide rails 63. On the other hand, the board 3 flexes to become flat under a load as shown in Fig. 13, and the rod members 61 in the case 13 becomes slidable in the fore and aft directions with respect to the guide rails 63. Other arrangements are the same as in the previous embodiment, so description will not be repeated here.~~

【0037】

Each of the right and the left arm portions 17b has a long hole 25 which extends in forward and rearward directions. The long hole 25 is provided with a wheel attaching shaft 27 which rotatably supports the wheel 5. Therefore, the attaching location of the front wheel or the wheel 5 is adjustable

within the long hole 25 by moving the wheel in the forward or rearward direction for a desired turning characteristic of the skateboard 1.

~~According to the present embodiment, even when the rider applies his load onto the board 3, making a generally center region of the board 3 displace (flex) in vertical directions, the guide rails 63 which support the case 13 moves in the fore and aft directions accordingly to the amount of displacement, i.e. the front guide rails 63 move forward and the rear guide rails move rearward, reducing the deformation load, vibration and so on exerted on the case 13. Use of the skateboard under such a condition does not deform the case 13 and so there is no adverse influence on the motor control means 12 including the controller 9, the battery 11 and so on. Further, since the board 3 is not subject to a resisting force from the case 13 against the deflection of the board 3, good operability by the feet is obtained, and natural comfortable ride can be assured due to suspension.~~

【0038】

Referring to Fig. 2~~Next, Figs. 14(a)-(c)~~ and Fig~~. 4, a hollow fixed sleeve 29 is provided inside the drive wheel or the wheel 7, and the drive motor 15 is fixed within the fixed sleeve 29. A bearing 31 is provided on each side of the fixed sleeve 29. The bearings 31 rotatably support the wheel 7. The fixed sleeve 29 has two side portions 29a, each integrally fixed to and supported by a supporting arm 35 via a wheel attaching shaft 3~~s. 15(a) and (b) show another embodiment in which a case 13 is supported on the bottom surface side of a

board 3.

~~In the present embodiment, four sets of bolts 65 and nuts 67 are used as supporting means, and the case 13 is provided with four long through holes 69 for insertion of the bolts 65. The bolts 65 should preferably be flat-headed so that the heads of bolts 65 will not protrude on the upper surface of the board 3 but will become flush with it.~~

【0039】

The supporting arm 35 is preferably formed in a downward facing U, and includes an upper arm portion 35a, and right and left arm portions 35b which provides a fixed support to the side portions 29a of the fixed sleeve 29. The upper arm portion 35a is pivotable freely in a range of 360 degrees around an arm shaft 37, and is supported by a fixed frame 39. The fixed frame 39 is integrally fixed to and supported on a bottom surface of the board 3 by a plurality of fastening bolts 41, for example.

~~Using the bolts 65 and the nuts 67 as described above, the case 13 is suspended on the bottom surface side of the board 3 at a space therefrom, as shown in Fig. 14 under no load. Under a load, the board 3 flexes downward as shown in Fig. 15, and the bolts 65 move in the long holes 69 toward the center of the board 3. Other arrangements are the same as in the previous embodiments, so description will not be repeated here.~~

【0040】

The drive motor 15 is controlled based on signals supplied from the controller 9, which is powered by a battery

11. A drive gear 45 is inserted around the motor shaft 43. The drive gear 45 engages with a middle gear 47, and the middle gear 47 engages with an internal gear 49 which is provided inside the wheel 7, whereby a rotating force after speed reduction in accordance with gear ratios between the gears is transmitted to the wheel 7.

~~According to the present embodiment, even when the rider applies his load onto the board 3, making a generally center region of the board 3 displace (flex) in vertical directions, the bolts 65 and the nuts 67 which support the case 13 moves in the directions indicated by Arrow A (in Fig. 14 and Fig. 15), accordingly to the amount of displacement, reducing the deformation load, vibration and so on exerted on the case 13. Use of the skateboard under such a condition does not deform the case 13 and so there is no adverse influence on the motor control means 12 including the controller 9, the battery 11 and so on. Further, since the board 3 is not subject to a resisting force from the case 13 against the deflection of the board 3, good operability by the feet is obtained, and natural comfortable ride can be assured due to suspension.~~

【0041】

As shown in Fig. 1 and Fig. 5, the controller 9 and the battery 11 are housed in a case 13, an approximately central region of which is fixed to and supported on the bottom surface of the board 3, with a fixing element such as fixing bolts 51, for example. Thus, front and rear ends of the case 13 are free ends. The fixing bolts 51 are preferably round-head bolts as shown in Fig. 5. Alternatively, flat-head bolts

may be used so the heads will not protrude from the board 3. Many other fixing elements and materials may be used to fix the case 13 to the board 3.

~~It should be noted here that not only the rear wheel 7 but also the front wheel 5 may be a drive wheel. In this case, the wheel 5 is also provided with a drive motor 15. When both of the wheels 5, 7 serve as the drive wheels, it is preferable as shown in Fig. 16, that two controllers 9a are used respectively for the wheels 5, 7, and the controllers 9a should be housed in the case 13.~~

【0042】

A fixed support via the fixing bolt 51 may be a single-point support at the approximate central region or a multi-point support. If the multi-point support is used, preferably as shown in Fig. 1, the fixing bolts 51 are preferably arranged to be aligned along Line X which crosses the board 3, i.e., substantially perpendicularly to the longitudinal directions of the board 3.

~~Further, the fixing means for fixing a generally center portion of the case 13 onto the bottom surface of the board 3 is not limited to the fixing bolt 51, but may be others such as an adhesive.~~

【0043】

The controller 9 is supplied with detection signals from a weight transfer detection sensor 53 located closer to the fore foot and a weight transfer detection sensor 55 placed closer to the rear foot as shown in Fig. 2. The weight

transfer detection sensor 53 for the fore foot is attached to the fixed frame 21 which supports the wheel 5 whereas the weight transfer detection sensor 55 for the rear foot is attached to the fixed frame 39 which supports the wheel 7.

~~The board 3 is not limited to wood, but may be made of other flexible structural member such as a synthetic resin.~~

【0044】

Referring to Fig. 7, the controller 7 includes a CPU 57 and a driver 59. The CPU 57 is supplied with a voltage at a voltage dividing point P of a voltage divider circuit which includes a series connection of the fore-foot and rear-foot weight transfer detection sensors 53, 55; a voltage from a speed sensor S provided by an encoder indicating the speed of wheel 7; and a drive current of the drive motor 15 supplied from a feedback circuit F. The CPU 57 and the driver 59 are mounted on a substrate which is preferably made of a material such as glass-epoxy resin or other suitable material.

【0045】

The weight transfer detection sensors 53, 55 for the forward and the rearward feet preferably have the same resistance characteristic. When a load is applied from the fore foot, the resistance value of the fore foot weight transfer detection sensor 53 decreases in inverse proportion to the load. When a load is applied from the rear foot, the resistance value of the rear foot weight transfer detection sensor 55 decreases in inverse proportion to the load. Therefore, when there is no load or the same amount of load exerted on both of the detection sensors 53 and 55, the

voltage at the voltage dividing point P of the voltage divider circuit becomes one half of voltage divider circuit source voltage V. On the other hand, when the rider transfers his weight on the board 3, to increase the load on the fore-foot weight transfer detection sensor 53 over the load on the rear-foot weight transfer detection sensor 55, the voltage becomes higher than V・1/2, by an amount that is proportional to the difference between the loads detected by the two detection sensors. Likewise, when the rider makes a weight transfer to decrease the load on the fore-foot weight transfer detection sensor 53 to become smaller than the load on the rear-foot weight transfer detection sensor 55, the voltage becomes lower than V・1/2, by an amount that is proportional to the difference between the loads detected by the two detection sensors.

【0046】

The CPU 57 generates a drive command signal (PWM: Pulse Width Modulation signal) whose pulse width represents the voltage at the voltage dividing point P of the voltage divider circuit, and sends the signal to the driver 59 at the next stage of the circuit. Based on the drive command signal from the CPU 57, the driver 59 outputs a drive current to the drive motor 15.

【0047】

According to the skateboard ~~The present invention being thus far described and illustrated in detail, it is obvious~~

~~that these description and drawings only represent an example of the present invention, and should not be interpreted as limiting the invention. The spirit and scope of the present invention is only limited by words used in the accompanied claims.~~

1 as described above, when the rider on the board 3 transfers his weight to his fore foot, the CPU 57 sends to the driver 59 a drive command signal which has a pulse width representing the difference between the loads on the forward-foot side and the rearward-foot side. The drive motor 15 is supplied with a drive current corresponding to the pulse width, and begins to accelerate or to travel forward. On the other hand, when the rider transfers his weight to his rear foot, the CPU 57 sends to the driver 59 a drive command signal which has a pulse width representing the difference between the loads on the forward-foot side and the rearward-foot side (a drive command signal which has a reverse amplitude of the amplitude when the weight transfer is to the fore foot). The drive motor 15 is supplied with a drive current corresponding to the pulse width, and begins to decelerate or to travel rearward.

【0048】

According to the skateboard 1 as described above, the case 13 is fixed at its generally central region by the fixing bolts 51, for example, thereby freeing up the front and rear ends of the case 13. Therefore, even if the load from the rider is applied to the board 3 and a generally central region of the board 3 deflects in a downward direction on the

fulcrums provided by the front and the rear wheels 5, 7 (e.g., even if a state change occurs from a state in Fig. 8 to a state in Fig. 9), the case 13 is not deformed, and there is no adverse influence on the motor controller 12 including the drive motor controller 9 and the battery 11 which are susceptible to deflection. Therefore, it becomes possible for example, to prevent a weld joint 11b from coming off the battery 11a, resulting in an electrically open circuit between the batteries 11a. Further, since the board 3 is not subject to a resisting force from the case 13 against the deflection of the board 3, good operability by the rider's feet is obtained, and a natural comfortable ride can be assured due to suspension.

【0049】

Further, the motor controller 12 supplies the wheel 7 with a rotary power in accordance with detection signals from the weight transfer detection sensors 53, 55. This makes possible to provide good control on the drive of the wheel 7 in accordance with the weight transfer of the rider.

【0050】

Next, Figs. 10(a) and (b) show another preferred embodiment in which a case 13 is supported on the bottom surface side of the board 3.

【0051】

In the present preferred embodiment, as clearly understood from Fig. 11, the case 13 preferably includes four rod members 61 on its two longitudinal side surfaces, each of the rod

members extending substantially perpendicularly to the side surface at a place closer to a longitudinal end of the side surface. On the other hand, the board 3 has a bottom surface provided with four guide rails 63, each of which has a generally L-shaped section and serves as supports for the rod members 61. As clearly understood from Fig. 10(b), each guide rail 63 is provided at a location corresponding to one of the rod members 61, and supports the rod member 61. Under this state, the center region of the case 13 is free.

【0052】

As shown in Fig. 12, the board 3 is upwardly curved under no load. The rod members 61 are non-slidingly supported by the guide rails 63. On the other hand, the board 3 flexes to become flat under a load as shown in Fig. 13, and the rod members 61 in the case 13 becomes slidable in the fore-and-aft directions with respect to the guide rails 63. Other arrangements are the same as in the previous preferred embodiment, so the description of these common features will not be repeated here.

【0053】

According to the present preferred embodiment, even when the rider applies a load onto the board 3, causing a generally central region of the board 3 to be displaced (flexed) in the vertical directions, the guide rails 63 which support the case 13 moves in the fore-and-aft directions according to the amount of displacement, i.e. the front guide rails 63 move forward and the rear guide rails move rearward, reducing the deformation load, vibration and so on exerted on

the case 13. Use of the skateboard under such a condition does not deform the case 13 and so there is no adverse influence on the motor controller 12 including the controller 9, the battery 11 and so on. Further, since the board 3 is not subject to a resisting force applied from the case 13 against the deflection of the board 3, good operability by the rider's feet is obtained, and a natural comfortable ride can be assured due to suspension.

【0054】

Next, Figs. 14(a)-(c) and Figs. 15(a) and (b) show another preferred embodiment in which a case 13 is supported on the bottom surface side of a board 3.

In the present preferred embodiment, four sets of bolts 65 and nuts 67 are preferably used as supports, and the case 13 is provided with four long through holes 69 for insertion of the bolts 65. The bolts 65 should preferably be flat-headed so that the heads of bolts 65 will not protrude on the upper surface of the board 3 but will become flush with it.

【0055】

Using the bolts 65 and the nuts 67 as described above, the case 13 is suspended on the bottom surface side of the board 3 spaced at a distance therefrom, as shown in Fig. 14 under no load. Under a load, the board 3 flexes downward as shown in Fig. 15, and the bolts 65 move in the long holes 69 toward the center of the board 3. Other arrangements are the same as in the previous preferred embodiments, so description of the common features will not be repeated here.

【0056】

According to the present preferred embodiment, even when the rider applies his load onto the board 3, causing a generally central region of the board 3 to be displaced (flexed) in vertical directions, the bolts 65 and the nuts 67 which support the case 13 move in the directions indicated by Arrow A (in Fig. 14 and Fig. 15), according to the amount of displacement, reducing the deformation load, vibration and so on exerted on the case 13. Use of the skateboard under such a condition does not deform the case 13 and so there is no adverse influence on the motor controller 12 including the controller 9, the battery 11 and so on. Further, since the board 3 is not subject to a resisting force from the case 13 against the deflection of the board 3, good operability by the rider's feet is obtained, and a natural comfortable ride can be assured due to suspension.

【0057】

It should be noted here that not only the rear wheel 7 but also the front wheel 5 may be a drive wheel. In this case, the wheel 5 is also provided with a drive motor 15. When both of the wheels 5, 7 serve as the drive wheels, it is preferable as shown in Fig. 16, that two controllers 9a are used respectively for the wheels 5, 7, and the controllers 9a should be housed in the case 13.

【0058】

Further, the fixing element arranged to fix a generally central portion of the case 13 onto the bottom surface of the board 3 is not limited to the fixing bolt 51, but may be constituted by other fixing elements or materials such as an

adhesive.

【0059】

The board 3 is not limited to wood, but may be made of other flexible structural members such as a synthetic resin.

【0060】

The present invention being thus far described and illustrated in detail, it is obvious that these descriptions and drawings only represent examples of preferred embodiments of the present invention, and should not be interpreted as limiting the present invention. The spirit and scope of the present invention is only limited by words used in the following claims.